Application of Risk Assessment Techniques to Railroad Safety Evaluation

Presentation to
The PTC Working Group of the RSAC

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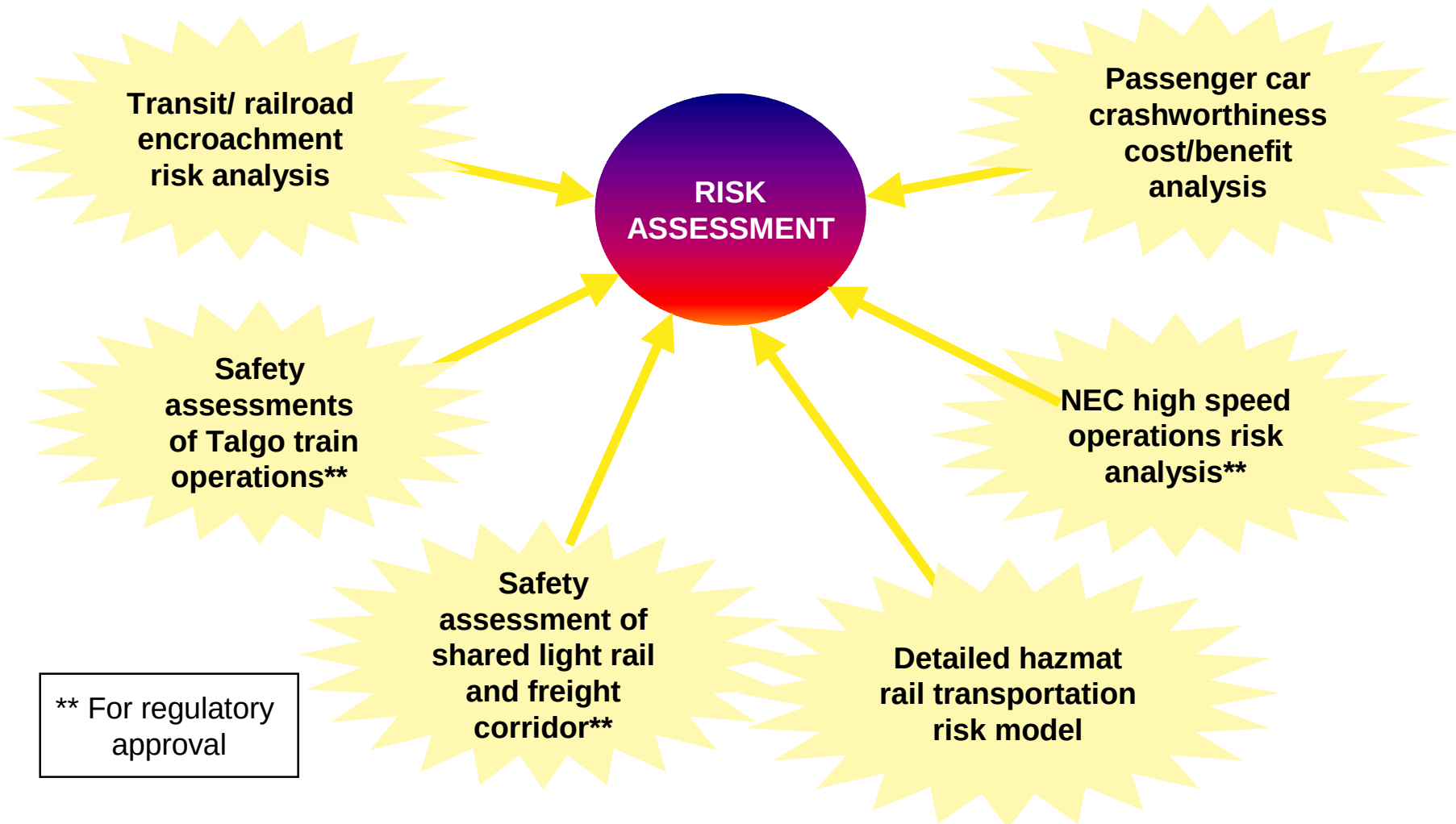
This presentation provides a brief summary of the application of risk assessment techniques to evaluating the safety performance of a railroad corridor under different plant, equipment and operating conditions.

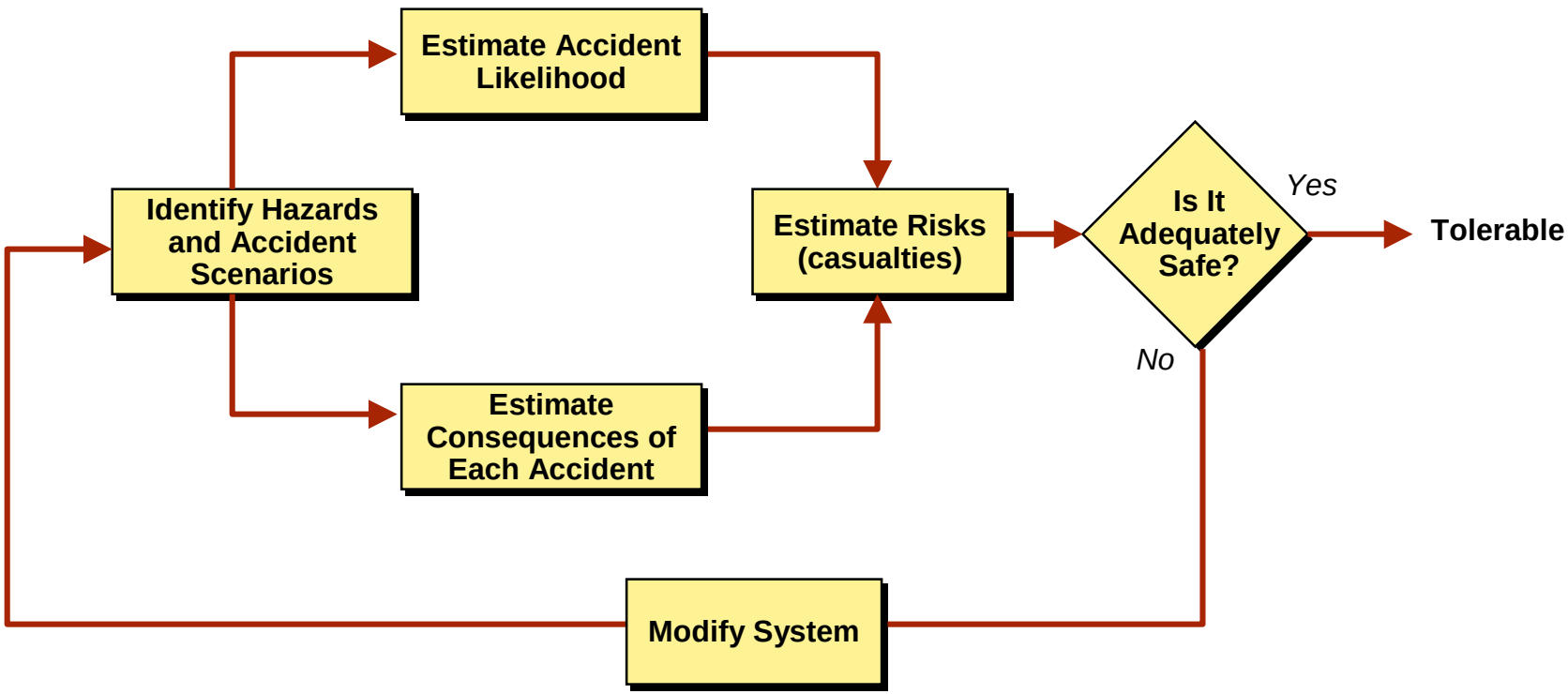
- Draws on the experience of railroad risk analyses by ICF Consulting predecessor, Arthur D. Little Inc., over the past several years
- Describes a basic risk assessment methodology
  - Identifying hazards, accident scenarios and inter-relationships
  - Estimating values for accident likelihood and consequences
  - Calculating and evaluating the resulting risk
- Discusses sources and analysis methods for risk model input data
  - Analysis of historic accident data
  - Engineering and operations analyses
  - Sources for exposure data

ICF Consulting predecessor Arthur D. Little has applied risk assessment techniques to a variety of railroad safety issues.



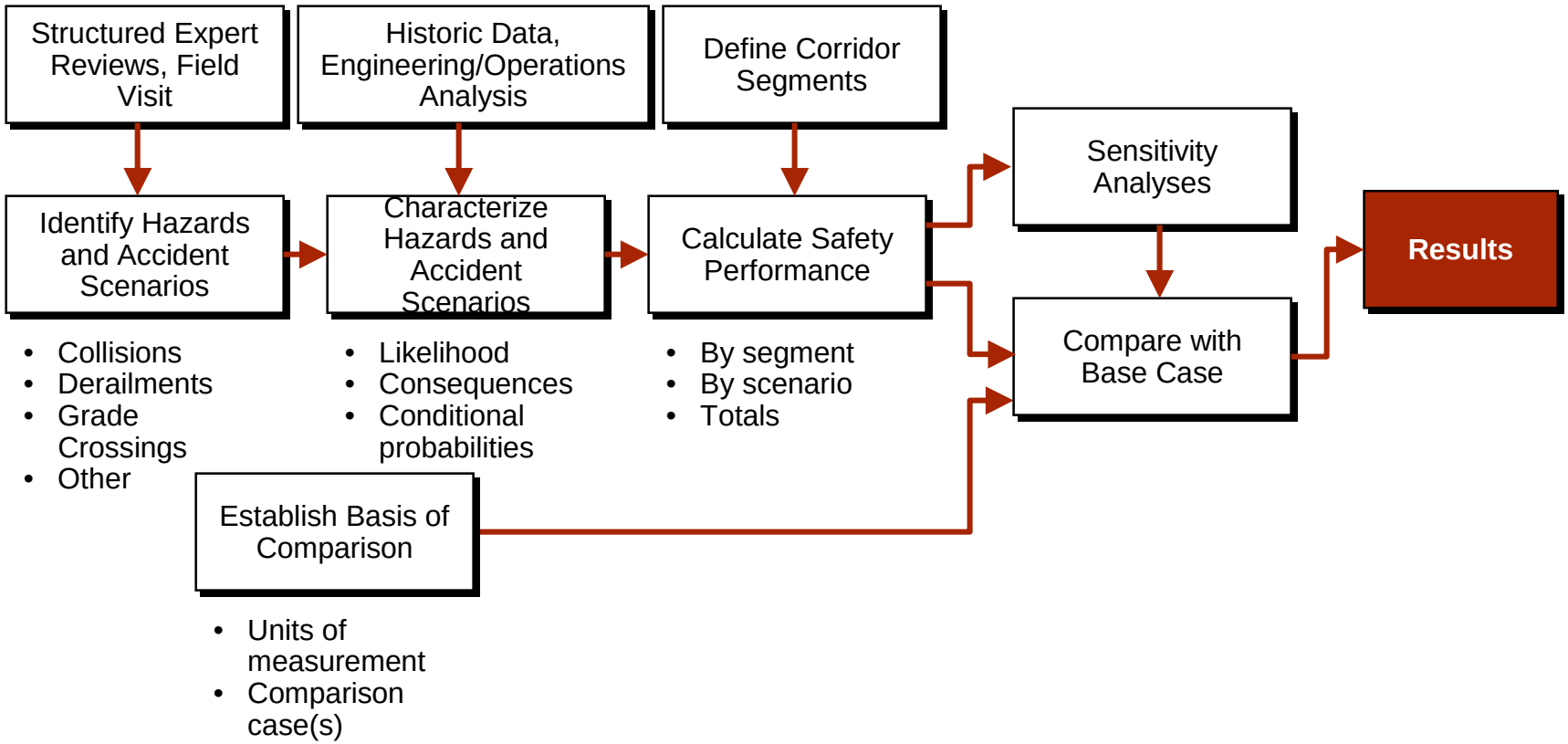
** For regulatory approval

Risk assessment is a logical process of identifying hazards, evaluating the seriousness of each hazard, and assessing the effectiveness of risk reduction measures.



Overall Risk Assessment Methodology

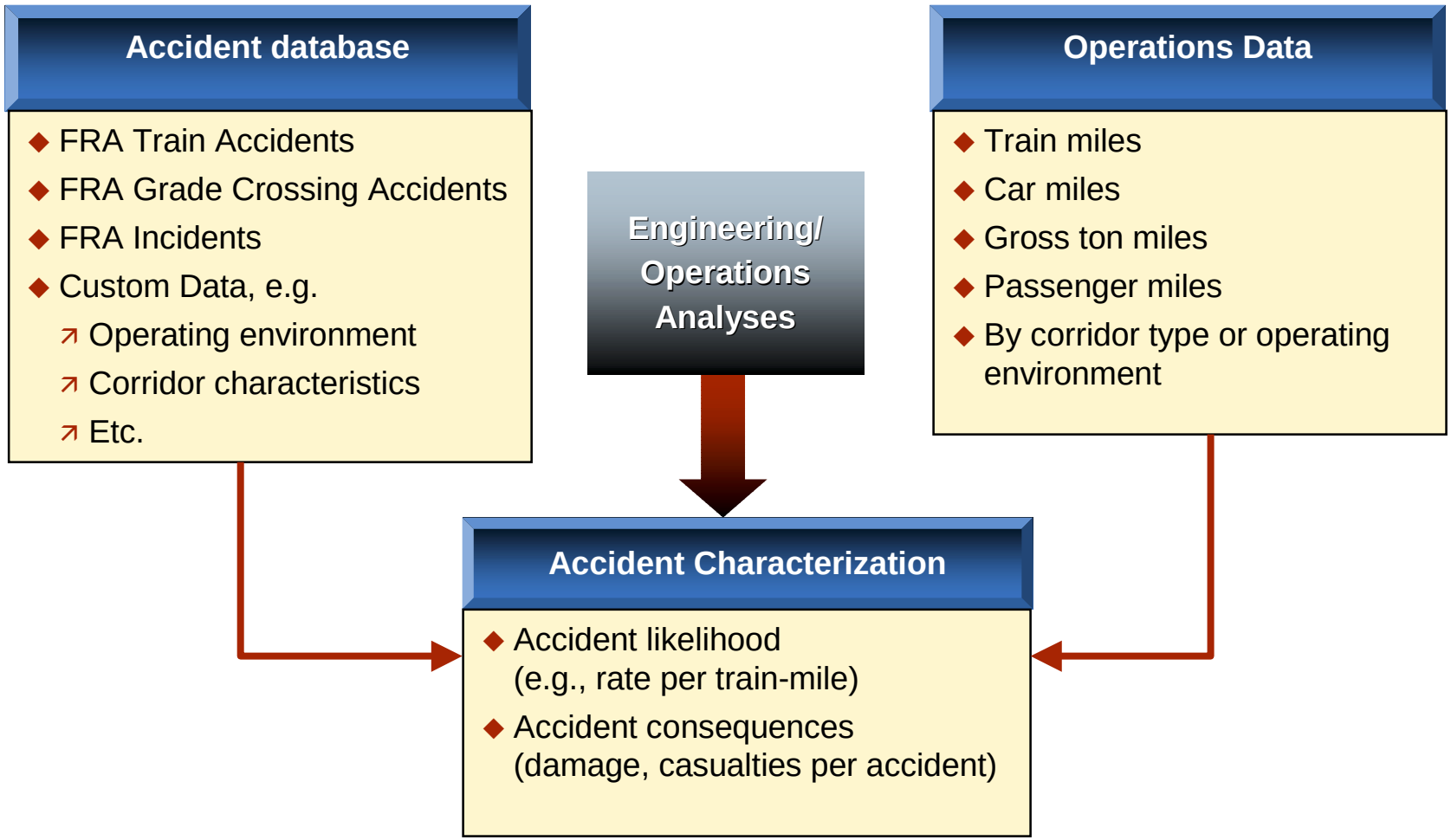
Risk analysis typically involves calculating the safety performance of a railroad corridor or corridors for each system alternative of interest for comparison with a base case representing existing operations.



A number of techniques may be used in the first stage of a risk assessment to identify hazards and define the structure of relationships between individual hazards and accident scenarios.

- FMEA/FMECA - Failure modes, Effects (and Criticality) Analysis
- PHA - Preliminary Hazard Analysis , often applied as part of a system safety program plan
- Fault and Event Tree Analysis - describes the structure of relationships between individual failures, especially parallel and serial events that result in a specific end event or accident scenario
- HAZOP - Hazard and Operability Analysis - a detailed, structured hazard analysis of a specific system or subsystem
- Experience based checklists

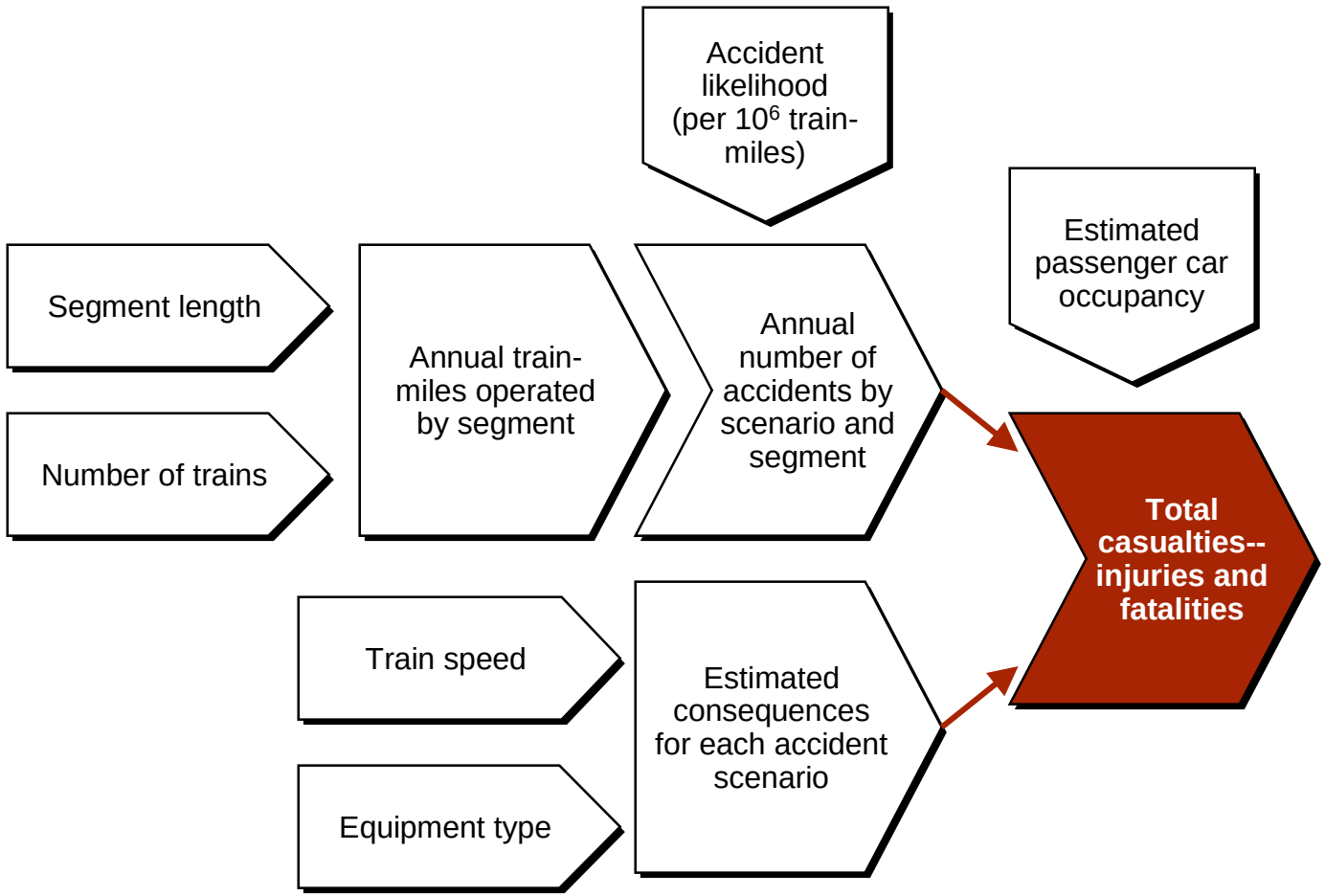
Train accident and operations data, plus engineering and operations analyses are used to characterize hazards and accident scenarios



Most of the effort in a risk assessment is directed to overcoming the biggest challenge: assembling the data to characterize hazards and accidents.

- Historical accident data often has to be supplemented with data from other sources and/or expert reviews of each accident
- Exposure or ‘denominator’ data (e.g. train-miles by train control method) is difficult to obtain, especially if access to railroad internal data is not available
- Costly and time-consuming engineering and operations analysis may be the only way to estimate required likelihood and consequence values
  - Passenger train crush and collision dynamics analyses
  - Train operations simulations to determine meet and pass occurrence
  - Dispersion modeling of the consequences of a hazmat release
  - Human factors analyses to estimate error likelihood

A spreadsheet model is used to calculate risk by accident scenario and corridor segment, and totals by segment and for the whole corridor.



This allows for changes in selected parameters to be easily examined.

Risk analysis is not an exact process and analysis results must be used with an understanding of their approximate nature.

- The ‘sample size’ of historic accidents for a specific accident type/operating environment can be small, leading to uncertainty in accident likelihood and consequence estimates
- There is an implicit assumption that typical industry practices are followed with regard to plant and equipment design, and operating and maintenance methods
- Corridor risk analysis do not normally take into account highly localized risks (e.g., a hazardous grade crossing)
- Engineering analyses and operating simulations are usually idealized or simplified, and cannot represent all real-life situations
- Comparisons between alternatives for corridor plant, equipment and operations are inherently more reliable than absolute estimates of accidents, damage and casualties

Experience with prior risk assessments suggests some points about the role of risk analysis in the safety acceptance of train control systems.

- Obviously, the greatest challenge is in estimating quantitative values for the likelihood of random and systemic faults in the train control systems and associated rules and procedures for operations and maintenance
- A “scoping” risk analysis should be done early in the project, to help set performance targets for system elements and to expose needs for supporting engineering and operations analyses
- Analysis plans should be discussed with FRA to make sure that the end result will meet their needs
- Avoid doing research as part of the analysis effort
- Monitoring of key risk indicators during operation of the system is essential to identify erroneous risk estimates and provide further safety assurance